fact that of the six female specimens now before me two have twenty, while the others have only nineteen annuli; in other words, the result to which I was led (*tom. cit.* p. 176), a good deal to my surprise, as to the great value of the number of rings in the body, is a little shaken, although it falls in rather with one's general experience as to the specific value of numbers such as these. It is to be noted, further, that the two females with twenty annuli measured respectively 75 and 80 millim., or less than three with nineteen rings, which measured 90, 95, and 105 millim.; a specimen of 46 millim. in length had nineteen rings.

The fact that the male has seventeen annuli, while that of *P. protelis* has sixteen or seventeen, and the discovery of the fact that the female of *P. polyzonum* is not absolutely limited to nineteen rings, diminishes the gap that separated the two species, Mr. Hoyle being apparently inclined to give as much importance as I did to the seeming constancy of the number of rings in the female.

While these considerations, then, tend to the union of the species *P. protelis* with *P. polyzonum*, the fact that the two animals, the small carnivore and the voracious snake, do live in the same area gives a clenching force which, to my mind, is almost irresistible.

XII.—*The Causes of Variation.* By Romyn Hitchcock*.

The recent studies of Dr. W. B. Carpenter upon *Orbitolites*† are of special interest, owing to the remarkable manner in which the stages of variation and development have been traced. The monograph by Dr. Carpenter, published in the Reports of the 'Challenger' Expedition, was the subject of some remarks recently made by the writer before the Biological Society of Washington, in which an effort was made to explain how such a simple sarcode organism as the animal *Orbitolites* has been led to produce a shell of complex form. Dr. Carpenter regards it as the expression of a not understood "progressive tendency along a definite line towards a higher specialized type of structure in the calcareous fabric." This, however, is merely a statement of the facts observed, and in no wise assists in their explanation. Elsewhere it may be gathered from the author's words that he regards the

* From the 'American Journal of Science' for July 1884, pp. 49–52.

† Phil. Trans. part ii. (1883).

complex shell as significant of a "*plan* so definite and obvious as to exclude the notion of '*casual*' or '*aimless*' variation."

The facts seem capable of a somewhat different interpretation, which seems more in accord with our present knowledge of simple organisms, and quite sustaining the views of Darwin that "plan," in the sense used by Dr. Carpenter, should be superfluous. For if there be an inherent tendency to variation among these organisms, as Dr. Carpenter seems to believe, how do we explain the persistence of the original Orbitoline type, *O. tenuissima*? Biologists seek to discover the causes of variations which they observe; but it seems not less important that the persistence of types should also be explained. *O. tenuissima* is a very ancient species, and surely any inherent tendency to change would have manifested itself during the long period of its existence, even under unfavourable conditions.

The observations I have to offer may be said to relate entirely to change of environment; but their tendency is to demonstrate that the changes observed in the shells of this family are not due to any inherent tendency resulting in a definite plan, but that they are due to causes easily understood.

It is far from my intention to deny a definite plan of growth to these organisms. But plan of growth does not imply that there have been causes acting within the organism—special tendencies of the protoplasm toward higher structure. It seems to be such an assumption that has led Dr. Carpenter to speak of a "not understood" progressive tendency, &c. In my opinion the causes of such progression as can be observed are easily understood; and the plan of growth becomes a natural consequence of these causes, which are purely physiological, and independent of any supposed tendency to variation. While Dr. Carpenter, on the one hand, seems to regard variation as due to an inherent tendency of the protoplasmic body, the writer, on the other hand, attributes it entirely to the more or less favourable conditions of life of the different species. Moreover, I am quite unable to understand how any inherent tendency to variation impressed upon the sarcode could fail to find expression in some differentiation of the sarcode, which in the cases in question has not been observed.

The same view seems to be held by O. Schmidt, who, in his 'Grundzüge einer Spongien-Fauna des Atlantischen Gebietes,' alludes to Dr. Carpenter's previous studies, and compares the changes observed in the Sponges and Foraminifera. He says the changes in the latter are found in the general habit of the form and the variable grouping of

the chamber-systems, while among the Sponges the variation is in the microscopic detail. "One may speak of the microscopic form of Foraminifera, but not of microscopic elements."

The complexity of the shell is merely in the multiplicity of chambers and the manner of their intercommunication. The process of growth, even in the complex *O. complanata*, is in all respects identical with that in other species, and in no essential feature differs from that of *Peneroplis*. What Dr. Carpenter designates as a "higher specialized type of structure" does not represent an advanced degree of specialization in any part; nor can we discover any advantage to the organism arising therefrom. It is true there is an advance in complexity; but unless accompanying this there is an evolution in function, or unless it results from some effort of adaptation which confers some benefit upon the organism, it seems not proper to regard complexity of shell-structure as a proof of biological advancement.

Seeking for an explanation of the cause of the increased complexity of shell-structure, so beautifully illustrated in the Milioline family, the writer was led to the conclusion that it is entirely due to the favourable conditions of life and the abundance of food available. It is true, as already said, this may be regarded as a mere statement of the influence of environment causing variation; but a careful consideration of the subject will show that there is a broad distinction between environment as a cause of variation and adaptation to environment; for in this case we are unable to perceive any benefit to the organisms arising from their adaptation to changed conditions.

If it be said we can seldom discover the benefits supposed to be derived from adaptation, it may be answered that it is usually possible to infer how the changes observed may prove beneficial. In the case under consideration, however, an examination of the changes that have taken place does not indicate any possible benefit to the organism. The multiplication of chamberlets necessitates very intimate intercommunication for the transference of food and the continuation of the processes of life. The organism is not thereby better adapted to its surroundings, but is made more dependent for its existence upon the continuance of the favourable conditions under which it has developed. The advance in complexity—the multiplication of chamberlets—would only be possible under the most favourable conditions, for all the nutriment received by the interior segments must be collected by the sarcode at the margin of the shell, and the necessary food could only be obtained where the supply was

abundant. It may be conceived that if *O. complanata* were placed in situations less favourable as regards food it would die of starvation, owing to the quantity of inner sarcode requiring nourishment, while *O. tenuissima* needs only more favourable conditions as regards food and, perhaps, temperature to become as highly complex in structure as the last-mentioned species. As a further proof of the influence of environment leading to changes which cannot be regarded as special adaptations, in the usual meaning of the word, the forms of *O. complanata* found on Fiji reef are especially characterized by thick plicated margins, as though growth proceeded with too great rapidity to produce symmetrical disks, and these forms are associated with the largest representatives of the species.

The distinction above referred to seems an important one, which, if it has already been recognized, has not been prominently brought forward in the writings with which I am familiar. Before the Biological Society the subject was briefly considered in the following words:—

"Regarding the subject from this point of view, we are led to examine more closely the relations between the spiral and the cyclical methods of growth. Their intimate relation is only noticeable when we observe how one has been derived from the other. When the spiral growth of *Orbiculina* produces a complete circular disk, further spiral growth becomes impossible; and if we concede that the extrusion of the sarcode to form successive chamberlets is due to nutrition and growth, the cyclical plan then becomes a necessity. In this way it may be supposed cyclical growth originated, purely a result of nutrition, not by adaptation to environment, but as a result of it; not because such growth is or ever was better adapted to the conditions of life.

"We find here a steady course of variation a result of physiological processes, independent of those external causes to which we are accustomed to attribute such changes. These variations, as successively produced, have been perpetuated through inheritance, until the plan of growth has, in some species, totally changed. Herein, therefore, we may find an indication of how the plan of growth originated, and a suggestion that the inscrutable laws which govern the progress of evolution may each have beginnings equally simple, and not beyond the range of human insight to discover. Evolution in this case seems not to be a result of a definite plan of growth, but the plan of growth is the result of physiological processes. However great and important the influences of environment and selection may have been in the production

of genera and species, perhaps the attractiveness of the idea and the ease with which it enables us to dimly understand many biogenetic problems permits us to lose sight of other influences more obscure, but of equal importance in the history of life."

This view of the subject seems to derive still further support from the geographical and bathymetrical distribution of the species. Without entering into a lengthy discussion of this part of the subject, it may be said that as a rule the more complex species are found in the warmer waters under conditions most favourable to the activity of nutritive processes. As an example, the very large specimens of *O. complanata* from Fiji reef may be taken. On the other hand, the ancestral form *O. tenuissima* still inhabits the colder and deeper waters, retaining the simple characters of its earliest known condition.

XIII.—*Additions to the present Knowledge of the Vertebrate Zoology of Persia.* By James A. Murray.

Since the publication of Mr. Blanford's valuable work on the Zoology of Persia (1876), giving a complete list of the animals inhabiting that country, nothing, I believe, has been published as an additional contribution, except a single paper in the Proc. Zool. Soc. for 1881, which added five species to the already large list of reptiles; these are *Agama persica*, *Scincus conirostris*, *Hydrophis temporalis*, *Catachlæna diadema*, and *Hydrophis cyanocincta*, the first three being newly described species.

The Kurrachee Museum, having now rather an extensive collection of Mammals, Birds, and Reptiles from Eastern Persia—very kindly made for the institution by Mr. W. D. Cumming, of the Persian Telegraph, during the past three years—and having also acquired a collection, comprising thirty-six species of Reptiles and seven Mammals (also from Persia) —made, it is said, by a member of some foreign exploring commission in 1876–77—I am enabled, after careful examination of these materials, to add a few more species to the existing knowledge of the Vertebrate fauna of the country.

For the collection said to be made by a member of some foreign commission, the institution is indebted to Mr. Possman, also of the Persian Telegraph. Although this collection dates as far back as 1876–77 the specimens are in an excel-